

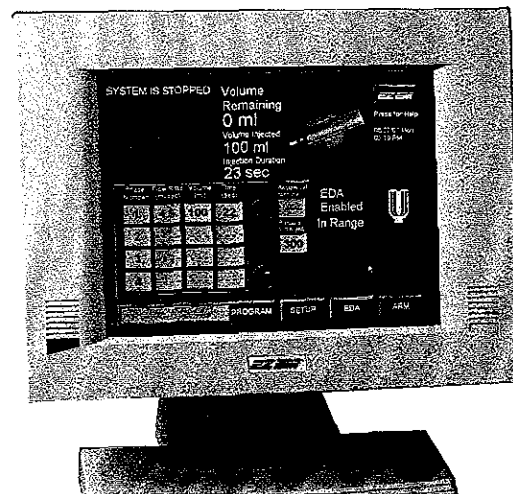
EZEVI[®]

EMPOWER_{CT}

Injector System

SERVICE MANUAL

CAT. # 98SM



CE0086

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READ THIS FIRST!



Observe the following warnings. Failure to comply may result in personal injury, death, or equipment damage.

1. Shock Hazard:

Lethal voltages are present. Use extreme care when servicing equipment with the AC/Mains power connected. Do not leave an open system unattended with the AC/Mains power connected. **DISCONNECT THE POWER SUPPLY AND REMOTE CONTROL AC/MAINS POWER CORDS BEFORE REMOVING OR REPLACING COMPONENTS.**

Make only proper electrical connections. Plug the AC/Mains power cords directly into grounded, hospital-grade for U.S. applications, three-pronged outlets. Do not use extension cords. Do not use an adapter to plug either of the AC/Mains power cords into a two-pronged, non-grounded outlet. Replace any worn or frayed wires immediately.

2. Explosion Hazard:

A risk of explosion exists if used in the presence of flammable anesthetics. Never operate the Empower CT[®] Injector System in the presence of any flammable gases.

3. Equipment Safety:

Only connect the Empower CT[®] Injector System's Power Supply and Remote Control to electrical sources of the proper voltage and frequency. If an incorrect voltage is used, the Injector system may be damaged when turned on.

The Empower CT[®] Injector System contains electrostatic sensitive components. You must wear a wrist grounding strap and place components on an anti-static pad. Failure to comply may result in damage to the equipment due to electrostatic discharge.

4. Unauthorized Modification and Repairs:

Unauthorized modifications to the Empower CT[®] Injector System will void your warranty. Authorized personnel should only perform servicing of internal parts. Opening or servicing of the Empower CT[®] Injector System by unauthorized personnel may result in injury, death, or damage to equipment, and will void your warranty.

5. Cautions and Warnings for the System:

Consult Empower CT User's Manual, document #018-0902 for Cautions and Warnings concerning the Empower CT Injector System.

Section 1: Introduction

1.1 PURPOSE OF THIS MANUAL

This service manual provides preventive inspection and service procedures to ensure proper operation of the Empower CT® Injector System. In addition, this manual provides troubleshooting and repair procedures to be performed by an authorized service technician. All references and procedures pertaining to the EDA should be disregarded for systems that do not include the EDA Module.

1.2 AUDIENCE

This manual is written for qualified technical personnel familiar with the operation and design of the Empower CT® Injector System and who have been authorized to service the system.

1.3 ORGANIZATION

This manual is organized into the following sections:

Read This First! precautions.	Discusses hazards and safety
Section 1: Introduction	identifies the purpose and organization of the manual.
Section 2: System Description	Provides a description of the system, mounting installations, tools and special equipment for testing, troubleshooting, and performing repairs.
Section 3: Periodic Inspection and Maintenance	Provides procedures for performing inspections, functional testing, and maintenance.
Section 4: Troubleshooting	Identifies symptoms, fault codes, error messages, and diagnostic procedures for fault isolation.
Section 5: Repairing and Replacing	Provides instructions for removing and replacing failed components and making adjustments.

Section 6: Software Installation	Provides instruction for installing software upgrades for the Injector, Remote Control, and the EDA.
Section 7: Test Requirements	Provides the test procedures to be completed after a repair has been completed.
Appendix A: Block Diagram	Provides a block diagram of the Injector, Remote Control, and EDA.
Appendix B: Parts List	Provides parts lists for system components.

1.4 RELATED DOCUMENTATION

User's Manual (Document No. 018-0902, Item No. 1476902)

Installation Manual (Document No. 018-0906, Item No. 1476906)

1.5 MANUAL CONVENTIONS

This manual uses the following conventions:

- ◆ **Bold** indicates emphasis or heading.
- ◆ Note is used to set off important information from the rest of the text.

This manual also uses the following warning format:



The **WARNING** symbol alerts you to a hazard that may result in equipment damage or personal injury.

Section 2: System Description

2.1 SYSTEM CONFIGURATION

The Empower CT® Injector System consists of the following:

- ♦ Injector
- ♦ Remote Control
- ♦ Power Supply
- ♦ Cables and AC/Mains power cords
- ♦ Pendant Switch.

The Injector is comprised of the Injector Head and the Injector Controller (see Figure 2-2a). When installed, the Injector and the Remote Control are connected to the Power Supply by a power/communications cable and a communications cable. The power/communications cable to the Injector provides power and communication signals. The communications cable to the Remote Control is for communications only.

The Power Supply (see Figure 2-2c) and the Remote Control (see Figure 2-2b) have their own AC/Mains power cords that may be plugged into separate wall receptacles. The Injector and the Remote Control have their own power switches and both must be set to the ON position to have the entire system powered up and operational.

The optional Extravasation Detection Accessory (EDA) is provided with the Extravasation Clip and mounting accessories (see Figure 2-2a). The EDA is powered from the Injector. Figure 2-1 provides an illustration of the Empower CT Injector System configuration with the EDA.

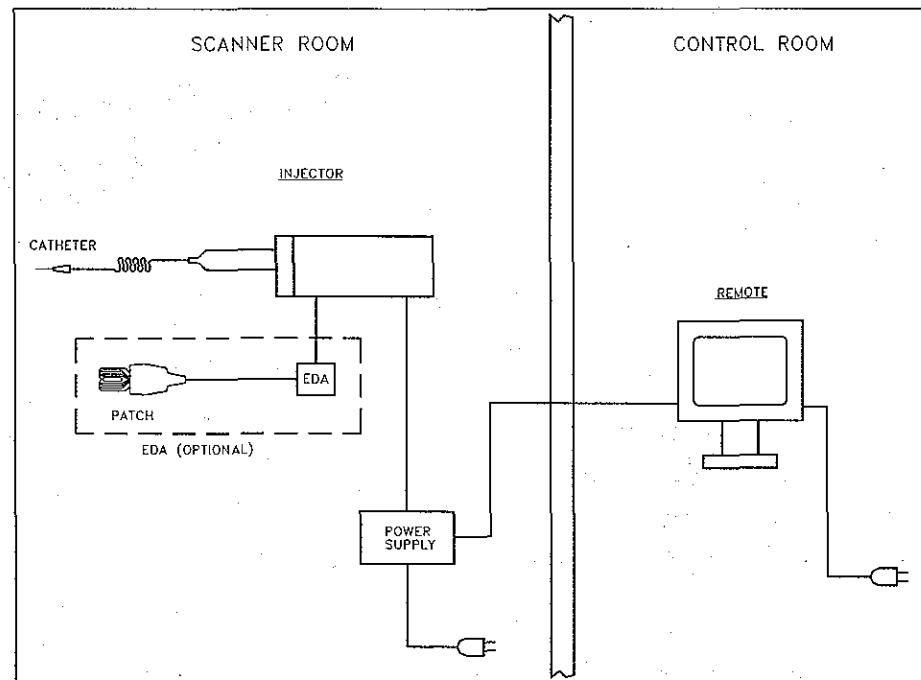


Figure 2-1: Basic Configuration

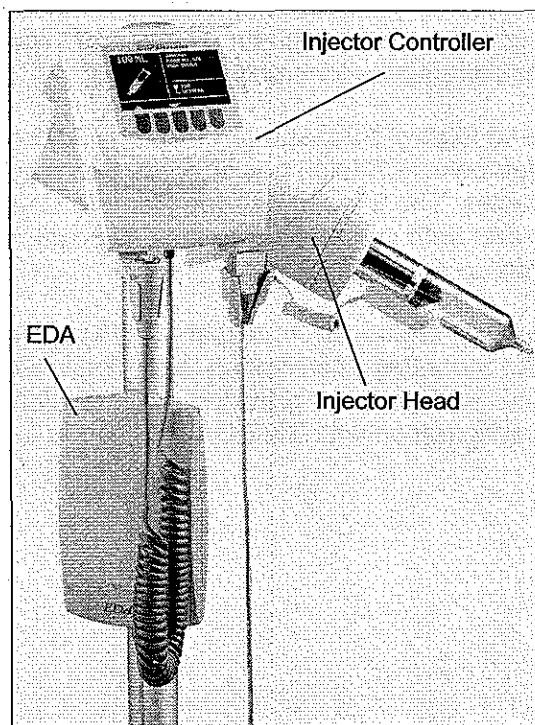


Figure 2-2a: Injector Floor Mount

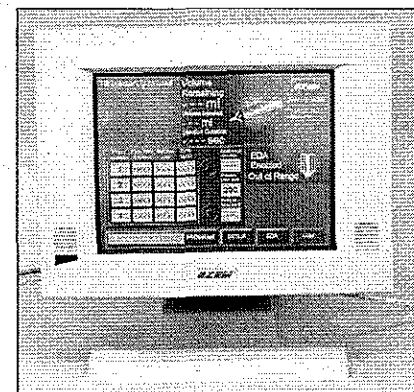


Figure 2-2b: Remote Control (Pedestal Mount)

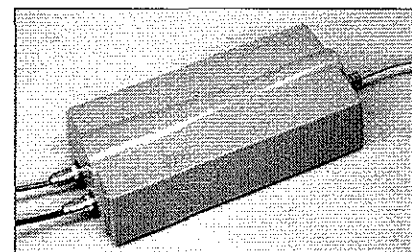


Figure 2-2c: Power Supply

2.2 MOUNTING SYSTEMS

The Injector and the EDA can be installed using the Injector Floor Stand for floor mounting, (see Figure 2-2a) or the overhead mounting system that uses an Articulating Arm that can be ceiling (see Figure 2-3) or wall mounted. A short, medium, or long Ceiling Mount Column is provided for ceiling mounting.

The Remote Control includes a pedestal mount for placement on a desk or other flat surface, or it can be wall mounted. The Power Supply can also be placed on a flat surface or wall mounted.

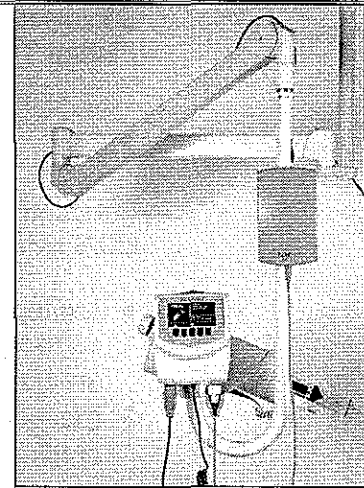


Figure 2-3: Overhead Mount

2.3 TOOLS AND TEST EQUIPMENT

In order to perform the necessary maintenance, troubleshooting and repair procedures, the technician is required to have the following tools and equipment:

2.3.1 Toolkit

The toolkit should contain the typical assortment of tools required by a technician to perform electrical work.

The kit should include:

- ◆ Wire cutters, pliers, various sizes of flat-edge and Phillips screwdrivers, Allen wrenches/hex keys, nut drivers, trimpot adjustment tool and wrenches
- ◆ 5 1/2 Digital multimeter (Extech Model MM570), test probe, wrist grounding strap, and anti-static pads.
- ◆ Specialized tools such as Milbar #4450R Retaining Ring Tool or equivalent, Milbar #4460R Retaining Ring Tool or equivalent, Spanner wrench, Heyco tool #R-29 or equivalent and Lumberg Spanner.
- ◆ Other equipment such as Glyptol, Loctite 242, isopropyl alcohol, and cotton swabs.
- ◆ At least four CT*Fast Load syringes (Catalog #6720)

2.3.2 Special Test Equipment

Special test equipment include the E-Z-EM Engineering Breakout Box, Test Fixture #018-8008. This special test equipment is a proprietary E-Z-EM Engineering designed test fixture for diagnostic purposes for the Empower

CT Injector electronics. In addition, the E-Z-EM Syringe Pressure Field Test Fixture TF #016-8065 is required for setting pressure profile constants.

2.3.3 Programming Equipment

Equipment necessary for programming the Injector, Remote Control, and EDA include:

- ◆ Laptop Computer (minimum requirements Windows 2000, HyperAccess software, Flashlink software, Pentium III or greater, 128 MB RAM, 2 GB or greater Hard Drive)
- ◆ CD-ROM with E-Z-EM Empower CT software revisions (can only be obtained through E-Z-EM Service Department)
- ◆ Single Board Computer Programming Cable, E-Z-EM Test Fixture TF #018-8013
- ◆ Ethernet Crossover Cable
- ◆ FlashLink Cable Set, modified by E-Z-EM
- ◆ Power Supply for programming the EDA, E-Z-EM Test Fixture #018-8035

2.3.4 Equipment for EDA Functional Testing

The following equipment is required for performing EDA functional testing as part of inspection and maintenance procedures (see Section 3 – Periodic Inspection and Maintenance).

- ◆ EDA Clip Assembly, Catalog #9871
- ◆ EDA Patch, Catalog #7881
- ◆ E-Z-EM EDA Field Test Fixture TF #017-8004

2.3.5 Jumpers and Test Probes

When troubleshooting, it may become necessary to short pins on the power/communications cable, communications cable, and the Power Supply in order to perform continuity testing. The following jumpers can be easily assembled by the technician and included in the toolkit:

1. Assemble jumper wire (see Figure 2-4a) with two male pins (equivalent: Tyco/Amp P/N 66591-1, male pin – 22-18 AWG).

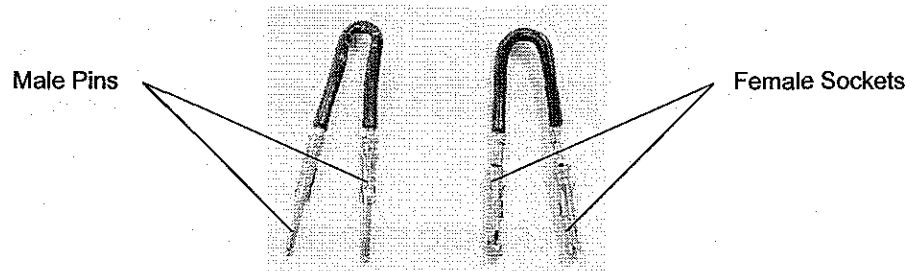


Figure 2-4a

2. Assemble jumper wire (see Figure 2-4a) with two female sockets (equivalent: Tyco/Amp P/N 66592-1, female socket – 22-18 AWG).

It will also be necessary to have a separate set of Digital Voltmeter test probes with lead pins that are sufficiently small to allow accurate measurements on the power/communications cable and communications cable pins. The test probes can be assembled by the technician and included in the toolkit.

1. If preferred, obtain an alternate set of test leads (equivalent: Radio Shack P/N 278-764).
2. Replace the lead pins with smaller male pins (equivalent: Tyco/Amp P/N 66591-1, male pin – 22-18 AWG). Crimp the pins to the wires and insulate with heat shrink tubing or electrical tape (see Figure 2-4b).

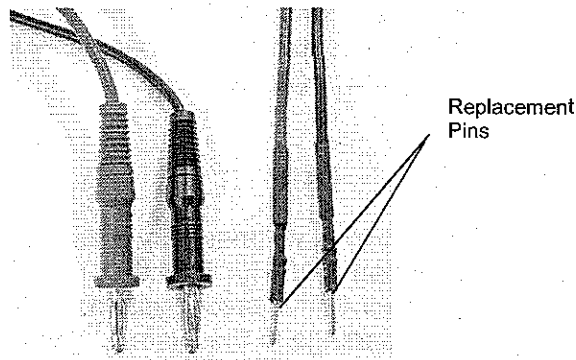


Figure 2-4b

Section 3: Periodic Inspection and Maintenance

3.1 PERIODIC PROCEDURES

Only qualified personnel should perform periodic inspection, maintenance, and service procedures.

3.1.1 Periodic Inspection

Qualified personnel should perform inspection once every twelve months. The Visual Inspection Test, section 3.3.1, Electrical Safety Test, section 3.3.2, Field Test Procedure section 3.3.3 and EDA Functional Test section 3.3.4 should be performed as the periodic inspection. During testing should any part of the Empower CT® Injector System fail inspection, notify E-Z-EM Service Department immediately.

3.1.2 Periodic Maintenance

Maintenance consists of cleaning the Empower CT® Injector System and should be performed on a regular basis or as needed. If it is not used for a prolonged period of time, it should be cleaned at least every six months. Follow the cleaning and storage instructions in Section 3.2 – Cleaning and Storage Procedure.

3.1.3 Service

Preventive maintenance and service must be performed by an authorized technician only who is familiar with the use, operation, and servicing of the Empower CT® Injector System. Unauthorized service may result in personal injury, damage to the system, and voiding of the warranty.

3.2 CLEANING AND STORAGE PROCEDURE

After each injection, remove and dispose of the Syringe in accordance with the *Empower CT® User's Manual*.

The Empower CT® Injector System should be cleaned when the day's schedule of injections is complete, in the event of accidental spills on the equipment, or as periodic maintenance. Using the following procedure:

1. Turn off power to the Injector.
2. Turn off power to the Remote Control.
3. Unplug the Power Supply's and Remote Control's AC/Mains power cords from their respective outlets.
4. Clean as follows:
 - a. For the Injector Controller, Injector Head, and Power Supply: dampen a paper towel with mild, hospital-grade disinfectant and carefully wipe off any dirt or spilled fluids.
 - b. For the Remote Control: Clean the touch screen with a soft towel and mild detergent.
5. Observe the following:
 - a. Do not autoclave.
 - b. Do not use strong disinfectants or cleansers.
 - c. Do not allow liquid cleaner to get inside system components.
 - d. Never submerge system components in water.



Failure to observe cleaning instructions may result in equipment damage and create an electrical hazard that can result in personal injury to the technologist and patient.

When not in use, the Empower CT Injector System should be stored in a safe place that avoids the possibility of spills or other accidental damage. It should be placed in an area away from dust, extreme or quickly changing temperatures.

3.3 INSPECTION & SAFETY CHECKLIST**3.3.1 Visual Inspection Test**

(Check either Pass or Fail)

	Pass	Fail	Inspection Step
1			<p>Inspect the Injector Controller and Injector Head's exterior case for physical damage, dents, holes, cracks, scrapes or scratches. Look for evidence of any missing screws or components.</p> <p>Check the labeling and review the owner's manual, especially with regard to injury prevention as outlined in the warnings and caution statements contained in the manual and labeled on the device.</p>
2			Inspect the Injector Controller's membrane panel for any punctures or tears.
3			Inspect the Injector Head's Syringe Nest (door) for smooth opening and closing movement.
4			Insert a CT Fast Load Syringe (catalog # 6720) into the Syringe Nest to ensure the disposable set seats properly and the Syringe Nest closes.
5			Inspect the Power Supply's exterior case for physical damage, dents, holes, cracks, scrapes or scratches. Look for evidence of any missing screws or components.
6			Ensure the Power Supply is located in an area with minimal traffic.
7			If the Power Supply is wall-mounted, ensure secure installation.
8			Inspect the Power Supply's AC/Mains power cord for damage, bent prongs, or a deformed connector.
9			Inspect the Remote Control's exterior case for physical damage, dents, holes, cracks, scrapes or scratches. Look for evidence of any missing screws or components.
10			If the Remote Control is wall-mounted, ensure installation is secure.

	Pass	Fail	Inspection Step
11			Inspect the Remote Control's touch screen for any punctures or tears.
12			Inspect the Remote Control's AC/Mains power cord for damage, bent prongs, or a deformed connector.
13			Inspect the power/communications and communications cables for damage, bent pins or deformed connectors.
14			If the system is either wall-mount or ceiling mounted, check that there are no cracks or bends in the articulating arm, mounting arm and wall/ceiling mount. Check that the arm has a full range of motion and the Injector can be easily maneuvered.

After Safety Checklist has been successfully completed, it should be filed by the facility.

3.3.2 Electrical Safety Test

These tests are inherently hazardous and should be performed by qualified biomedical personnel. Proper precautions should be exercised when conducting such tests.



Failure to exercise proper precautions may result in equipment damage and create an electrical hazard that can result in personal injury to the technologist and patient.

Pass	Fail	Electrical Inspection
		<p>A periodic electrical inspection by hospital biomedical personnel should be conducted as per established hospital protocol and the following:</p> <p>Check electrical safety ground resistance, including the Power Supply and Remote Control AC/Mains power cords in accordance with IEC 60601-1, UL2601-1 Section 3 Part 18:</p> <p>Record measured value _____ milliohms. Measured value should less or equal to 100 milliohms.</p> <p>Tested By: _____</p>
		<p>Check the enclosure leakage current in accordance with IEC 60601-1, UL2601, Section 3, Part 19:</p> <p>Record measured value _____ μA.</p> <p>Measured value should be less than or equal to 300 μA.</p> <p>Tested By: _____</p>
		<p>Check the patient leakage current in accordance with IEC 60601-1, UL2601, Section 3, Part 19:</p> <p>Record first measured value _____ μA. Measured value should be less than or equal to 10 μA.</p> <p>Tested By: _____</p>

Note: If any defects or out of specifications are found during the course of these technical safety tests that could potentially interfere with proper Empower CT operation or be dangerous to the patient and/or operator or third parties, remove the system from operation immediately. Do not attempt to use it.

After Electrical Safety Test has been successfully completed, it should be filed by the facility.

3.3.3 Field Test Procedure

(see section 7.1 for Field Test Procedure)

3.3.4 EDA Functional Test

3.3.4.1 EDA Calibration Check

1. Install the EDA Field Test Fixture, TF #017-8004 and set the resistance value to 35.7 ohms. Verify the Remote Control Test Fixture displays "EDA Enabled- Out of Range".
2. Set the resistance value to 100 ohms. Verify that the Remote Control Test Fixture displays "EDA Enabled-In Range".
3. Flip the switches down on the test box. Verify that the Remote Control Test Fixture displays "EDA Enabled – Out of Range". Return the switches to the UP position.
4. Set the resistance value to 249 ohms. Verify that the Remote Control Test Fixture displays "EDA Enabled- Out of Range".
5. Disconnect the EDA Field Test Fixture.

If during check, the proper message is not displayed, see section 7.6 for Calibration of the EDA PCB.

3.3.4.2 EDA System Check

1. Verify that the systems are communicating by the absence of the "NOT FOUND" messages on the Injector and Remote.
2. Place EDA Patch, Catalog # 7881 on forearm.
3. Connect the EDA Clip Assembly, catalog # 9871 to EDA Patch.
4. Verify that after a few seconds, the system displays "EDA Enabled – In Range".
5. Initialize the system and auto-fill to 125 ml.
6. For phase one, set a flow rate of 2.0 ml/sec and a volume of 100 ml.
7. Press the ARM key on the Remote Control or Injector. Verify that system is armed.
8. Wait a few seconds and then press the RUN key.
9. After the Volume Injected passes 20 ml, disconnect the EDA Clip from the EDA Patch.

10. Verify that approximately 5-10 seconds after the disconnection from the patch, the system pauses. Verify that the system displays 'EDA Enabled-Out of Range'.
11. Reconnect the EDA Clip to the EDA Patch. Verify that the system displays "EDA Enabled-In Range".
12. Press the RUN key on the Remote Control. Allow the injection to come to completion.
13. Verify that after the injection is completed, the system displays "EDA Enabled-No Baseline" and then displays "EDA Enabled-In Range".
14. Power the system OFF. Disconnect all connections. Remove EDA Patch.

Note: If during testing, an out of specification is noted, contact E-Z-EM Service Department

Section 4: Troubleshooting

4.1 ORGANIZATION

This section provides troubleshooting procedures for detecting and identifying malfunctions in the Empower CT Injector System. It may be necessary to open parts of the system for purposes of performing additional diagnostics or replacing faulty components, at which point the technician will be referred to Section 5 – Repairing and Replacing for disassembly instructions.

The troubleshooting procedures are divided into six categories and are presented in the order of complexity beginning with the simpler and more obvious faults and moving on to more advanced diagnostics.

General Topic Problem	Description of Problem	Section
Preliminary Diagnostic	General diagnosis before repairing system.	Section 4.2
Mechanical Problems	Injector Head or Injector Controller does not rotate properly.	Section 4.3
Power Failure Diagnostics	The Injector, Remote Control, or both fail to power up.	Section 4.4
Communication Problem	The system is displaying "Injector Not Found", "Remote Control Not Found", or "EDA Not Found".	Section 4.5
Fault Codes	The Injector and/or Remote are displaying a Fault Code.	Section 4.6
Miscellaneous System Problem	EDA Out of Range, Door Open/Close Fault, Door will not Open/Close, Syringe Warmer, Membrane Keys, EL Display & Pendant	Section 4.7

4.2 PRELIMINARY DIAGNOSTIC

Infrequently the system is suspected of a malfunction when, in fact, it is fully operational. This can be the result of human error, failure of other equipment, and poor connections. Before attempting any lengthy diagnostics or repair actions, always follow the preliminary diagnostic steps presented below.

1. Ensure that the Power Supply's and Remote Control's AC/Mains power cords are plugged into electrical outlets and into their respective devices.
2. Check all cables for proper connections and possible damage.
3. Visually inspect all components for foreign substance or damage.
4. Test the outlets for proper voltages.
5. Check the Injector, Remote Control, and EDA software revision levels on the Remote Control's Service Screen. Consult with E-Z-EM Service Department for the latest applicable software revisions (see section 6).
6. Make several attempts to recreate the problem including applying and removing power to the Injector and Remote Control several times. If the problem does not reoccur, return the system to operation.

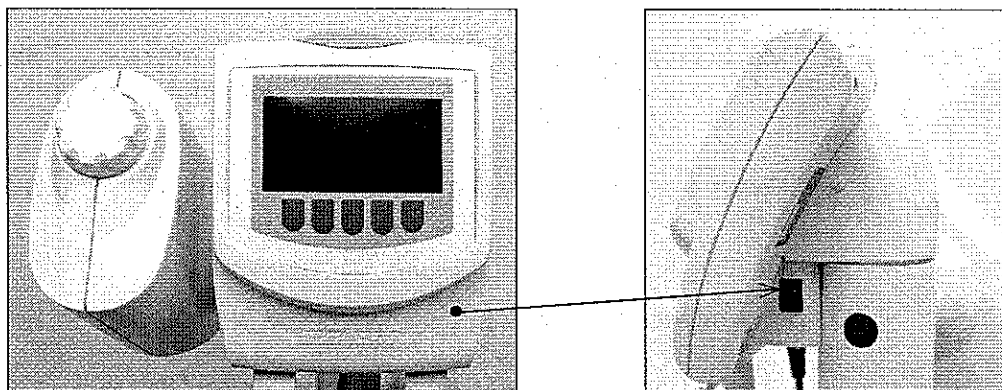


Figure 4-1: Injector Controller's Power Switch

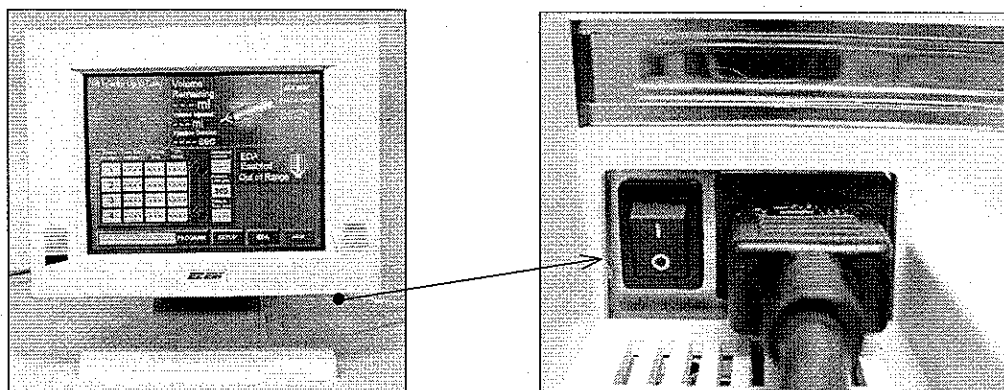


Figure 4-2: Remote Control's Power Switch

4.3 MECHANICAL PROBLEMS

The Injector Controller and the Injector Head can be positioned by rotating them on the vertical axis and horizontal axis respectively. They can be easily rotated by hand but provide sufficient resistance so that they do not move when released. This section addresses problems with rotating the Injector Controller or Injector Head.

4.3.1 Injector Controller Pivot Malfunction

The Injector Controller pivots too loosely or has too much resistance making it difficult to turn. This requires repair of the Controller Pivot Assembly (see Section 5.2.1 – Repairing the Controller Pivot Assembly).

4.3.2 Injector Head Tilt Malfunction

The Injector Head pivots too loosely or has too much resistance making it difficult to turn. This requires adjustment of the lock nut located in the side of the Injector Pivot (see Section 5.2.2 – Adjusting the Injector Head Pivot).

4.4 POWER FAILURES

This section provides diagnostics for the following power failures:

- ◆ Injector does not power on
- ◆ Remote Control does not power on
- ◆ The Injector and Remote Control fail to power up
- ◆ Injector Loses Power after Injector Head is Activated

4.4.1 Injector Fails to Power Up

Upon powering up, the Injector Controller will emit an audible tone and the EL display will illuminate and display a power-up screen followed by the STOP screen. The section below describes if Injector Controller fails to respond when power is applied to the Injector.

Required Tools: Phillips screwdriver
flat-edge screwdriver

Required Test Equipment: digital voltmeter or test probe

1. Power down the Injector and the Remote Control.
2. Unplug the Power Supply's AC/Mains power cord from the outlet and test the outlet voltage using the digital voltmeter or test probe.

- > If the voltage for 115 VAC is between 100-130 VAC or for 220 is between 200-240 VAC, proceed to next step
 - > Otherwise, notify facility personnel.
3. Disconnect the power/communications cable from the Injector pigtail cable and plug the AC/Mains power cord back into the outlet.
 4. Using the digital voltmeter, measure the voltage on both pins shown in Figure 4-3a using one of the Gnd pins then repeat using the other Gnd pin. The reading should be between 24-32 VDC.

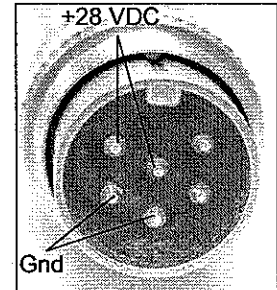


Figure 4-3a:
power/communications

- > If all measurements are out of specification, skip to Section 4.4.1.1 – Power Supply and Cables Troubleshooting.
- > If at least one measurement is within specification, proceed to the next step.

5. Do the following:

- a. Reconnect the power/communications cable to the Injector pigtail cable.
- b. Remove the Injector Controller Cable Cover (see Section 5.4.1 – Replacing the Injector Controller Cable Cover).
- c. Disconnect the 6-pin connector (see Figure 4-3b) and measure across the following pins:

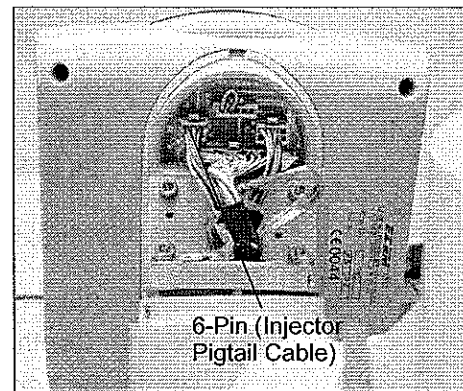


Figure 4-3b: Controller PCB

- ◆ pin #1 (black): +28 VDC and pin #3 (yellow): Gnd
- ◆ pin #2 (green): +28 VDC and pin #3 (yellow): Gnd
- ◆ pin #1 (black): +28 VDC and pin #4 (red): Gnd
- ◆ pin #2 (green): +28 VDC and pin #4 (red): Gnd

All measurements should be between 24-32 VDC.

- > If all the voltage measurements are outside specification, replace the Injector pigtail cable (see Section 5.3.1 – Replacing the Injector Pigtail Cable).
- > If at least one voltage measurement is within specification, proceed to the next step. (The Injector will power up as long as there is one good path).

6. Do the following:
 - a. Verify the Injector is powered down.
 - b. Reconnect the 6-pin connector to the back of the Controller's PCB.
 - c. Disconnect the 8-pin connector and 24-pin connector from the back of the Controller's PCB then set the Injector's power switch to the on position. The Injector Controller should emit an audible tone.
 - > If no tone is emitted, skip to Section 4.4.1.2 – Injector Controller Troubleshooting.
 - > If a tone is emitted, proceed to the next step.
 - d. Power down the Injector. Reconnect the 24-pin connector then power the Injector back up. The Injector Controller should emit an audible tone.
 - > If no tone is emitted, skip to Section 4.4.1.3 – Injector Head Troubleshooting.
 - > If a tone is emitted, skip to Section 4.4.1.4 – EDA Troubleshooting.

4.4.1.1 Power Supply and Cables Troubleshooting

The Power Supply, power/communications cable, and the AC/Mains power cord are suspect.

Required Tools: Phillips screwdriver
Flat-edge screwdriver

Required Test Equipment: digital voltmeter

1. Disconnect the power/communications cable from the Power Supply.
2. Using the digital voltmeter, measure the voltage on both pins as shown in Figure 4-4a using one of the Gnd pins then repeat using the other Gnd pin. The measured voltage should be between 24-32 VDC.

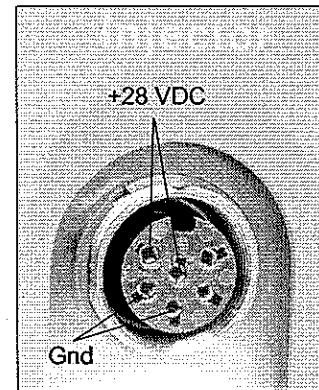


Figure 4-4a: Power Supply

- > If at least one measurement is within specification, replace the power/communications cable (see Section 5.9.1 – Replacing the power/communications Cable).
 - > If all measurements are outside specification, proceed to the next step.
3. Disconnect the AC/Mains power cord from the outlet and from the Power Supply. Test the power cord for opens and shorts using the digital voltmeter.
 - > If the AC/Mains power cord has any open or shorts, replace the power cord (see Section 5.9.6 – Replacing the Power Supply).
 - > Otherwise proceed to the next step.
 4. Do the following:
 - a. Remove the four corner Phillips screws (see Figure 4-4b) on the bottom of the Power Supply and remove the top enclosure.
 - b. Use a flat-edge screwdriver to remove the two fuse-holders and fuses (see Figure 4-4c).
 - c. Test the fuses for continuity with the digital voltmeter.
 - > If both fuses are good, replace the Power Supply (see Section 5.9.6 – Replacing the Power Supply).
 - > If one or both fuses are bad, replace fuses (F6.3 Amp, Fast Blow, 250 VAC, 5 x 20 mm) and retest. If the fuses blow again, replace the Power Supply (see Section 5.9.6 – Replacing the Power Supply).

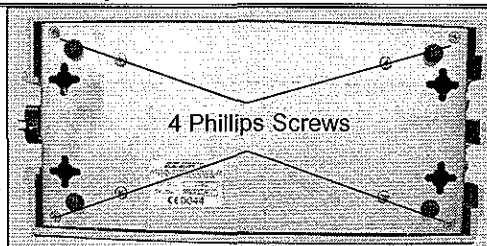


Figure 4-4b: Power Supply



Figure 4-4c: Power Supply

4.4.1.2 Injector Controller Troubleshooting

The following troubleshoots the Injector's power switch, Controller PCB, Single Board Computer (SBC), and EL display.

Required Tools: Phillips screwdriver

Required Test Equipment: digital voltmeter and breakout box

1. Power down the Injector.
2. Remove the Injector Controller's Front Enclosure as follows:
 - a. Remove the four corner Phillips screws from the Injector Controller's Rear Enclosure (see Figure 4-5a).
 - b. Gently lift the Front Enclosure just a few inches and disconnect the two ribbon cables from the Controller PCB (see Figure 4-5b). Place the Front Enclosure on a clean surface.

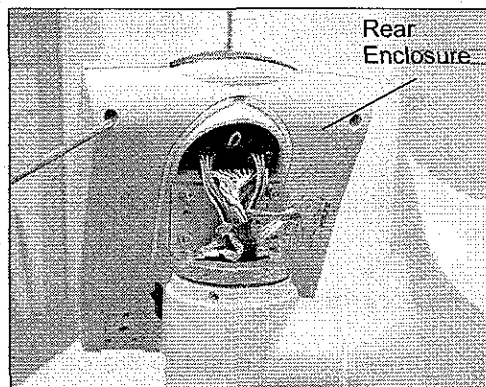


Figure 4-5a: Injector Controller

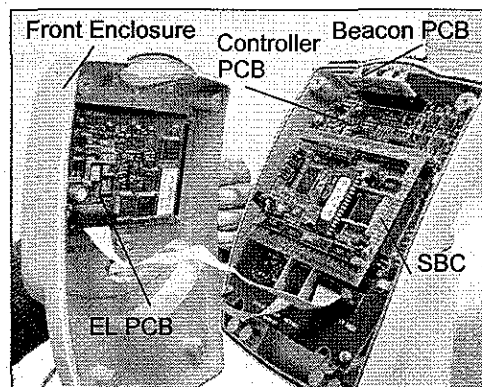


Figure 4-5b: Injector Controller

3. Power up the Injector. The Injector Controller should emit an audible tone.
 - > If a tone is emitted, replace the EL display (see Section 5.4.5 – Replacing the EL Display).
 - > If no tone is emitted, proceed to the next step.

4. Test the Injector's power switch as follows:
 - a. Connect the breakout box's ribbon cable to the Controller PCB (see Figures 4-6a and 4-6b).
 - b. Connect the digital voltmeter test leads to the breakout box (pin #33 = +28 VDC, pin #34 = Gnd).
 - c. Set the Injector's power switch to the on and off positions several times. Observe that the digital voltmeter shows the switch opening and closing by displaying between 24-32 VDC when the switch is on and displaying approximately 0 VDC when the switch is off.
 - > If the digital voltmeter does not show the switch opening and closing, replace the power switch (see Section 5.4.9 – Replacing the Injector's Power Switch Assembly).
 - > If the digital voltmeter shows the switch opening and closing, disconnect the breakout box from the Controller PCB and proceed to the next step.

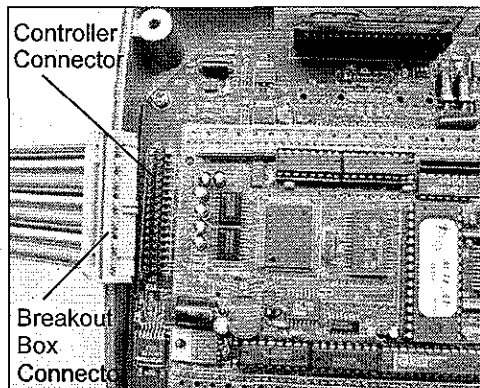


Figure 4-6a: Connecting the Breakout Box

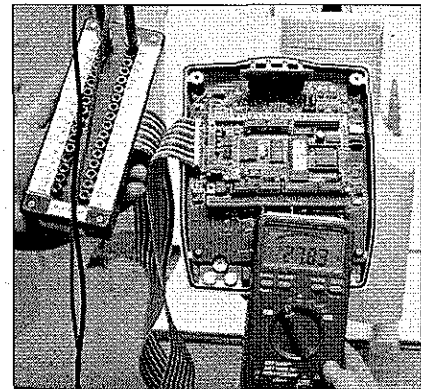


Figure 4-6b: Testing the Power Switch

5. If the system is being **field-tested**, replace the Controller PCB and the SBC (see Section 5.4.4 – Replacing the Controller PCB). Do **not** attempt to separate the two boards.

If the system is being **factory-tested**, do the following:

- a. Ensure the Injector's power switch is set to the off position.
- b. Gently remove the SBC from the Controller PCB. It is mounted on connectors on four sides.
- c. Power on the Injector. The Injector Controller should emit an audible tone.
 - > If a tone is emitted, replace the SBC (see Section 5.4.3 – Replacing the Single Board Computer).
 - > If no tone is emitted, replace the Controller PCB (see Section 5.4.4 – Replacing the Controller PCB).

IMPORTANT!

When replacing the SBC, record its serial number. Next, obtain the Pressure Profile consisting of the two values (m & b constants) specific to the system. These numbers must be entered into the system when installing a new SBC (see section 5.4.3.3 and 5.4.3.4).

4.4.1.3 Injector Head Troubleshooting

The system will not power on and the suspect portion is in the Injector Head.

Required Tools: Phillips screwdriver

1. Power down the Injector.
2. Disconnect the Syringe Warmer from the Injector Head. Power on the Injector. The Injector Controller should emit an audible tone.
 - > If a tone is emitted, replace the Syringe Warmer.
 - > If no tone is emitted, proceed to the next step.
3. Power down the Injector. Remove the Injector Head's Rear Enclosure as follows:
 - a. Pull off the Injector Hand Knob at the rear of the Injector Head (see Figure 4-7a).
 - b. Remove four Phillips screws from the Injector Head's Rear Enclosure (see Figure 4-7a).
 - c. Gently slide the Rear Enclosure towards the rear of the Injector Head and pull away a few inches (see Figure 4-7b).
 - d. Disconnect the heater harness from J5 on the Interconnect PCB (see Figure 4-7c). Place the Rear Enclosure on a clean surface.

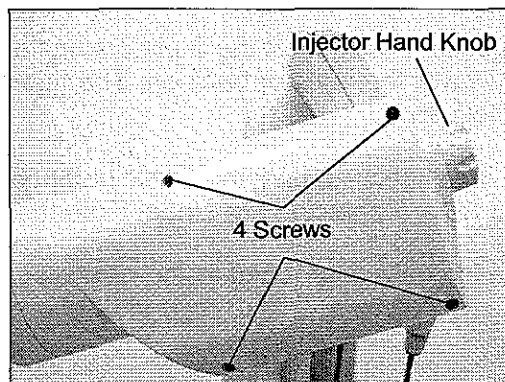


Figure 4-7a: Removing the Rear Enclosure

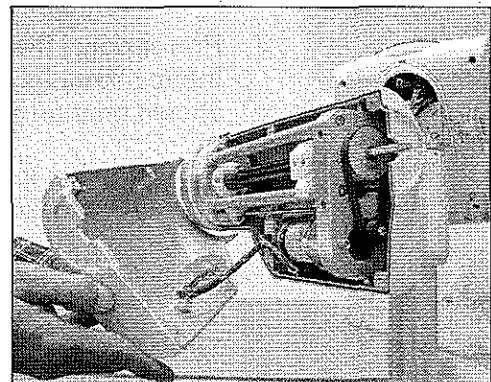


Figure 4-7b: Removing the Rear Enclosure

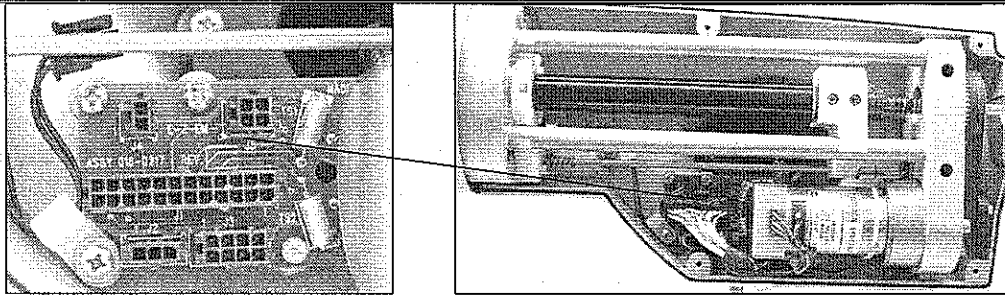


Figure 4-7c: Interconnect PCB

4. Power up the Injector. The Injector Controller should emit an audible tone.
 - > If a tone is emitted, replace the heater harness (see Section 5.5.3 – Replacing the Heater Harness).
 - > If no tone is emitted, proceed to the next step.
5. Power down the Injector. Disconnect the 2-pin connector from J4 on the Interconnect PCB. Power the Injector back on. The Injector Controller should emit an audible tone.
 - > If a tone is emitted, replace the door sensor (see Section 5.5.5 – Replacing the Door Sensor).
 - > If no tone is emitted, proceed to the next step.
6. Power down the Injector. Disconnect the 8-pin connector from J3 on the Interconnect PCB. Power the Injector back on. The Injector Controller should emit an audible tone.
 - > If a tone is emitted, replace the motor (see Section 5.5.5 – Replacing the Motor).
 - > If no tone is emitted, proceed to the next step.
7. Power down the Injector. Disconnect the 3-pin connector from J2 on the Interconnect PCB. Power the Injector back on. The Injector Controller should emit an audible tone.
 - > If a tone is emitted, replace the linear potentiometer (see Section 5.5.7 – Replacing the Linear Potentiometer).
 - > If no tone is emitted, proceed to the next step.

8. Power down the Injector. Disconnect the 24-pin connector from J1 on the Interconnect PCB. Power the Injector back on. The Injector Controller should emit an audible tone.
 - > If a tone is emitted, replace the 24-pin cable. This cable can only be replaced at the factory (see Section 5.3.3 – Replacing the 24-Pin Cable). **Return the Injector for repair.**
 - > If no tone is emitted, replace the Interconnect PCB (see Section 5.5.9 – Replacing the Interconnect PCB).

4.4.1.4 EDA Troubleshooting

If an EDA is installed, do the following:

Required Tools: Phillips screwdriver

Required Test Equipment: digital voltmeter

1. Power down the Injector and reconnect the 8-pin connector to the back of the Controller's PCB.
2. Remove the EDA module from its mounting. Remove the four Phillips screws and remove the bracket (see Figure 4-8a).
3. Disconnect the EDA pigtail cable from the back of the EDA module (see Figure 4-8b) then power the Injector back on. The Injector Controller should emit an audible tone.
 - > If no tone is emitted, replace the EDA pigtail cable (see Section 5.3.2 – Replacing the EDA Pigtail Cable).
 - > If a tone is emitted, proceed to Step 4.
4. Remove the EDA PCB (see Section 5.8.1 – Replacing the EDA PCB). Use the digital voltmeter to test the EDA PCB to Power/Comm. Connector Harness. This harness connects from the EDA PCB to the EDA Rear Enclosure. Test for short circuits between pins and for an open circuit in each path.
 - > If a short circuit or an open circuit is detected, replace the EDA PCB to Power/Comm. Connector Harness (see Section 5.8.2 – Replacing the EDA PCB to Power/Comm. Connector Harness).
 - > If all paths are good, replace the EDA PCB (see Section 5.8.1 – Replacing the EDA PCB).

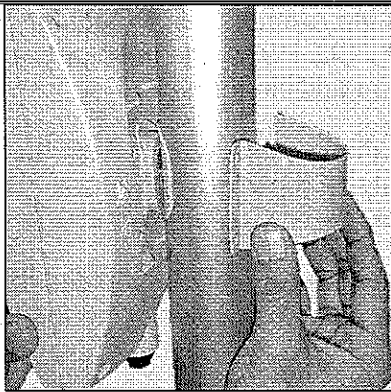


Figure 4-8a: Dismounting the EDA

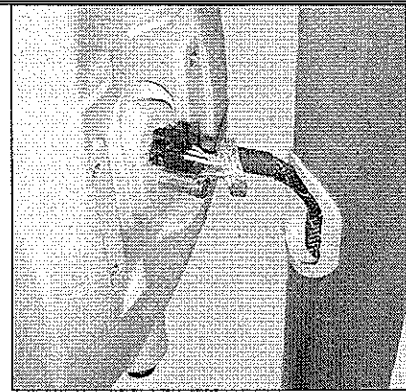


Figure 4-8b: EDA Connector

4.4.2 Remote Control Fails to Power Up

The Remote Control fails to power up.

Required Test Equipment: digital voltmeter and test probes

1. Power down the Injector and the Remote Control.
2. Disconnect the Remote Control's AC/Mains power cord from the outlet and test the outlet voltage using the digital voltmeter or test probe.
 - > If the voltage for 115 VAC is between 100-130 VAC or for 220 is between 200-240 VAC, proceed to next step.
 - > Otherwise, notify facility personnel.
3. Disconnect the AC/Mains power cord from the Remote Control, and test the power cord for opens and shorts using the digital voltmeter.
 - > If the AC/Mains power cord has any opens or shorts, replace the power cord (see Section 5.9.6 – Replacing the Power Supply).
 - > If the AC/Mains power cord does **NOT** have any opens or shorts, proceed to the next step.
4. Do the following:
 - a. Disconnect the communications cable from the Remote Communication Box Assembly (see Figure 4-9).
 - b. Disconnect the Remote Power Cable Assembly from the KB/Mouse port in back of the Remote Control (see Figure 4-9).
 - c. Remove the Remote Communication Box Assembly

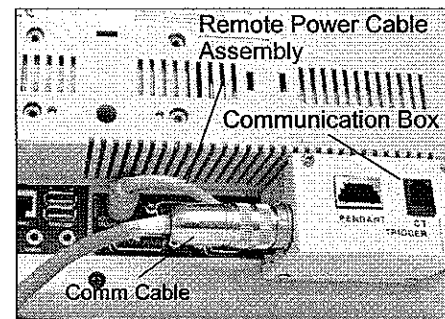


Figure 4-9: Remote Comm. Box Ass'y

(see Section 5.7.2 – Replacing the Communication Box Assembly).

- d. Reconnect the AC/Mains power cord to the Remote Control and plug it into an outlet. Power up the Remote Control.
 - > If the Remote Control does not power up, replace the Remote Control (see Section 5.9.7 – Replacing the Remote Control).
 - > If **field-testing** and the Remote Control powers up, replace the Remote Communication Box Assembly (see Section 5.7.2 – Replacing the Remote Communication Box Assembly).
 - > If **factory testing** and the Remote Control powers up, proceed to Step 5.

5. For **factory testing** – do the following:

- a. Remove the Remote Interface Cover and disconnect the Remote Power Cable Assembly from P1 on the Remote PCB Assembly (see Section 5.7.1 – Replacing the Remote Interface Cover).
- b. Use the digital voltmeter to test the Remote Power Cable Assembly. Test for short circuits between pins and for an open circuit in each path.
 - > If a short circuit or an open circuit is detected, replace the Remote Power Cable Assembly (see Section 5.7.3 – Replacing the Remote Power Cable Assembly).
 - > Otherwise, replace the combined Remote Interconnect PCB and Remote Communications PCB Assemblies (see Section 5.7.5 – Replacing the Remote PCB Assembly).

4.4.3 Injector and Remote Control Fail to Power Up

Both, the Injector and the Remote Control fail to power up. Neither provides any visual or audible indications of activity.

The Injector's Power Supply and the Remote Control have their own AC/Mains power cords that are plugged into separate outlets. It is unlikely that the failure of a single component will prevent both of them from powering up. Should they both fail to power up, do the following:

Required Test Equipment: digital voltmeter or test probe

1. Test the voltages at both outlets. Both outlets may be on the same branch as a tripped circuit breaker. If both voltages are within specification for the facility, proceed to the next step.
2. Treat this problem as separate failures and refer to Section 4.4.1 – Injector Fails to Power Up and Section 4.4.2 – Remote Control Fails to Power Up.

4.4.4 Injector Loses Power after Injector ram is moved

When power is applied to the Injector but power is lost when the Injector ram is moved. Replace components in the following order (power down the Injector before each replacement and retest the system after each replacement):

- (1) Syringe Warmer (see Section 5.5.2 – Replacing the Syringe Warmer)
- (2) Controller PCB (see Section 5.4.4 – Replacing the Controller PCB)
- (3) Power Supply (see Section 5.9.6 – Replacing the Power Supply)

4.5 COMMUNICATION MESSAGES

This section provides procedures for troubleshooting **Injector Not Found**, **Remote Control Not Found**, and **EDA Not Found** communication messages. If the Injector Controller or Remote Control displays a numerical fault code, refer to **Section 4.6 – Fault Codes**.

4.5.1 The Message Not Found on One Component Only

If the Injector displays the message “Remote Not Found” and the Remote does **NOT** display “Injector Not Found” or if the Remote displays the message “Injector Not Found” and the Injector does **NOT** display “Remote Not Found”, the cause of this problem is related to an incompatible revision of software. Follow the steps below to obtain the software revisions of the system:

- a. If the Remote Control is already powered up, proceed to the next step; otherwise, power it up. Power up the Injector.
- b. After the Remote Control has booted up and is displaying the Stop Mode Main Screen, press the **SETUP** button. The Setup Screen is displayed.
- c. Press the **SERVICE** button. A keyboard is displayed.
- d. Key in service password (obtained through E-Z-EM Service Department) and press **ENTER**. The Service Screen is displayed.
- e. Obtain from E-Z-EM Service Department, the latest applicable service revisions.
- f. Use Section 6: Software Installation to update the appropriate component to the latest applicable revision.

4.5.2 Injector Not Found/Remote Control Not Found Messages

Generally, whenever the Injector Controller displays **Remote Control Not Found**, the Remote Control will also display **Injector Not Found**, providing both have powered up successfully.

Required Tools: jumper wire See Section 2.3.5 – Jumpers and Test Probes.

Required Test Equipment: digital voltmeter (test leads must have small pins – and see Section 2.3.5 – Jumpers and Test Probes)

1. Observe if the Injector or the Remote Control failed to power up or to boot up.
 - > If the Remote Control displays **Injector Not Found** and the Injector failed to power up, go to Section 4.4.1 – Injector Fails to Power Up.
 - > If the Injector Controller displays **Remote Control Not Found** and the Remote Control failed to power up, go to Section 4.4.2 – Remote Control Fails to Power Up.
 - > If the Injector Controller displays **Remote Control Not Found**, and the Remote Control has powered up but did not boot up successfully, replace the Remote Control.
 - > If none of the above, proceed to the next step.
2. Power down the Injector and the Remote Control. Unplug the Power Supply's AC/Mains power cord from its outlet. **This step is necessary to prevent equipment damage when shorting pins in the following steps.**



Failure to unplug the Power Supply's AC/Mains power cord can result in equipment damage.

3. Disconnect the power/communications cable from the Injector cable and disconnect the communications cable from the Remote Control. Leave both cables connected to the power supply.
4. Using the digital voltmeter, test for shorts between pins on the power/communications cable connector.

Hint: Select a pin and measure the resistance between that pin and each of the other pins on the same connector. Repeat for all other pins until all combinations have been tested. All measurements should show an open circuit.

- > If any measurement shows a short circuit, go to Section 4.5.1.2—Cables/Power Supply Troubleshooting.

- > If all measurements show open circuits, proceed to the next step.
5. Using the digital voltmeter, test paths A, B, and C for open circuits by measuring across corresponding pins on the power/communications and the communications cable connectors (see Figure 4-10a).

Hint: If the power/communications and the communications cable connectors cannot be brought close together to perform continuity testing, use the jumper with the female sockets to short pins A and B on the communications cable connector (see Figure 4-10b) and test for a closed circuit across pins A and B on the power/communications cable connector. Repeat for pins A and C.

- > If any measurement shows an open circuit, go to Section 4.5.1.2—Cables/Power Supply Troubleshooting.
- > If all measurements show closed circuits, go to Section 4.5.1.1—Injector/Remote Control Troubleshooting.

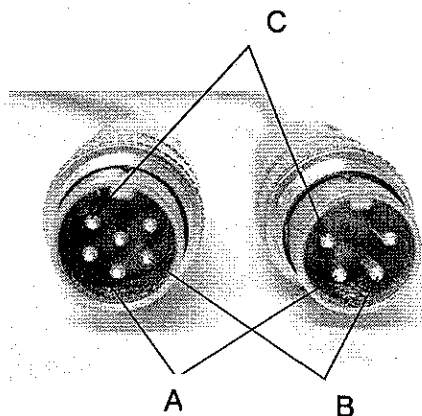


Figure 4-10c: Corresponding Pins

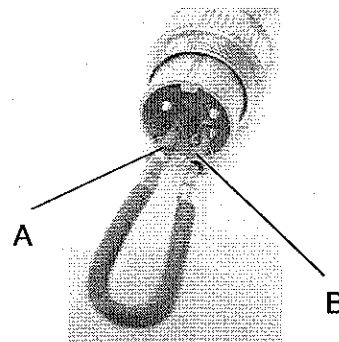


Figure 4-10d: Shorting Pins

4.5.2.1 Injector/Remote Control Troubleshooting

Reconnect the power/communications cable to the Injector cable and the communications cable to the Remote Control. Plug the Power Supply AC/Mains power cord into its wall outlet.

1. If the system is being **field-tested**, proceed to Step 2. If the system is being **factory-tested**, skip to Step 3.
2. For **field-testing** – replace components in the following order (power down the Injector and the Remote Control before each replacement and retest the system after each replacement):
 - (a) Remote Communication Box Assembly (see Section 5.7.2 – Replacing the Remote Communication Box Assembly)
 - (b) Remote Control (see Section 5.9.7 – Replacing the Remote Control)
 - (c) Controller PCB (see Section 5.4.4 – Replacing the Controller PCB)

- (d) Single Board Computer (see Section 5.4.3 – Replacing the Single Board Computer)

3. For **factory testing**, do the following:

- a. Disconnect the communications cable from the Remote Communication Box Assembly.
- b. Disconnect the Remote Power Cable Assembly from the KB/Mouse port in back of the Remote Control (see Figure 4-11a).

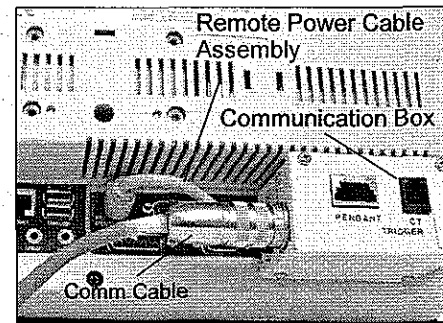


Figure 4-11a: Remote Comm. Box Ass'y

- c. Remove the Remote Interface Cover (see Section 5.7.1 – Replacing the Remote Interface Cover) and disconnect the Remote Power Cable Assembly from P1 on the Remote PCB Assembly (see Figure 4-11b).

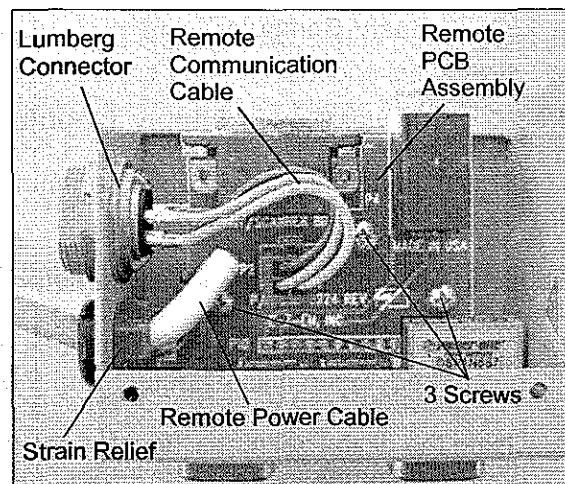


Figure 4-11b: Remote Cables

- d. Use the digital voltmeter to test the Remote Power Cable Assembly. Test for short circuits between pins and for an open circuit in each path.
 - > If a short circuit or an open circuit is detected, replace the Remote Power Cable Assembly (see Section 5.7.3 – Replacing the Remote Power Cable Assembly).
 - > Otherwise, proceed to the next step.
- e. Disconnect the Remote Communications Cable (inside the Remote Communication Box) from P2 (see Figure 4-11b).
- f. Use the digital voltmeter to test the Remote Communications Cable. Test for short circuits between pins and for an open circuit in each path.

4.7 MISCELLANEOUS SYSTEM PROBLEMS

The following identifies failures that be would be detected by the user during normal operation or inspection. They do not cause the system to display communication messages or fault codes.

4.7.1 EDA is Out of Range or Cannot Establish Baseline

This section applies to systems that have the EDA installed. The Injector Controller and the Remote Control display either of the following messages:

EDA ENABLED – OUT OF RANGE

EDA ENABLED – NO BASELINE

Note: These messages show EDA status during normal operation and do not necessarily reflect system problems. A problem may exist only if the message is not cleared after technologist intervention.

Required Tools: EDA patch – catalog #7881
Cotton swab
Alcohol

1. Set the Injector's power switch to the off position.
2. Ensure the following conditions are met and retest after each step:
 - a. There are no damaged parts of the EDA Clip (look for cracks and frayed wiring).
 - b. EDA Clip connector is properly attached to the EDA module.
 - c. EDA Clip is properly attached to the EDA patch (Catalog #7881).
 - d. EDA patch is properly adhering to skin.
3. If the problem still exists, do the following and retest after each step:
 - a. Clean the gold contacts on the EDA Clip using a cotton swab and alcohol.
 - b. Replace the EDA Clip cable assembly.
 - c. Remove the EDA PCB (see Section 5.8.1 – Replacing the EDA PCB). Use the digital voltmeter to test the EDA Receptacle Assembly. Test for short circuits between pins and for an open circuit in each path.
 - > If a short circuit or an open circuit is detected, replace the EDA Receptacle Assembly (see Section 5.8.3 – Replacing the EDA Receptacle Assembly).
 - > Otherwise, replace the EDA PCB (see Section 5.8.1 – Replacing the EDA PCB).

4.7.2 Syringe Nest Does Not Open or Close

The Syringe Nest is the movable part of the Syringe Door. If it cannot be opened or closed, the Locking Detent Rod in the Injector Mechanism is suspect.

*Note: The Syringe Nest can be opened only when the system displays **REPLACE SYRINGE**.*

1. Remove the Injector Mechanism from the Injector Head (see Section 5.5.4 – Replacing the Injector Mechanism).
2. Inspect the Locking Detent Rod. Make certain that the bowed e-ring is in place and undamaged (see Figure 4-18). If necessary, replace the bowed e-ring; otherwise, replace the Detent Rod (see Section 5.5.8 – Replacing the Locking Detent Rod Assembly).

Note: The bowed e-ring is located on the Detent Rod between the Anti-Rotation Bracket and the Motor and Bearing Mounting Plate. It is curved with the concave side (curving inward) facing the Anti-Rotation Bracket.

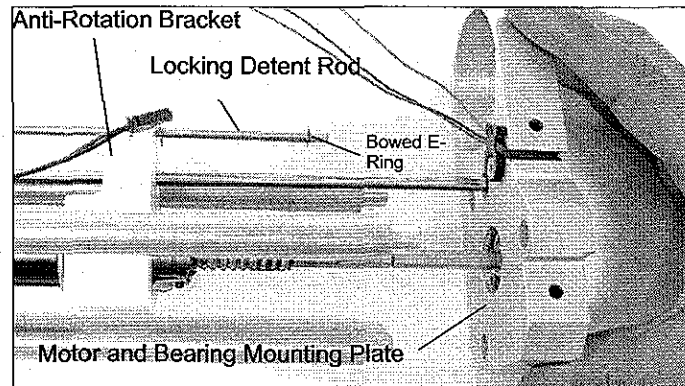


Figure 4-18: Injector Mechanism

4.7.3 False Door Open Message

The system falsely displays **DOOR OPEN** when the Syringe Nest Door is actually closed, or it fails to display **DOOR OPEN** when the Syringe Nest Door is open.

*Required Test Equipment: digital voltmeter
E-Z-EM breakout box*

1. Bring Injector ram to the Replace syringe position. Power down the Injector.
2. Remove the Injector Controller's Front Enclosure (see Section 5.4.2 – Replacing the Injector Controller's Front Enclosure).

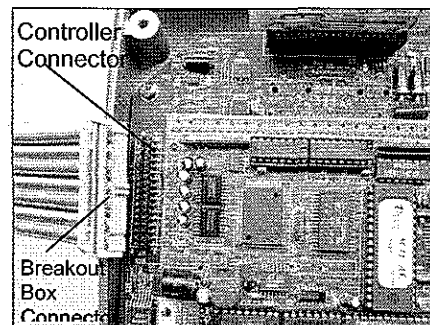


Figure 4-19a: Connecting the Breakout Box

3. Test the system as follows:
 - a. Connect the breakout box's ribbon cable to the Controller PCB (see Figure 4-19a).
 - b. Connect the digital voltmeter test leads to the breakout box (pin #4 = + VDC, pin #34 = Gnd).
 - c. Power up the Injector then open and close the Syringe Nest Door a few times. Observe that the digital voltmeter shows the Syringe Nest Door opening and closing by displaying 0 to 1 VDC when the Syringe Nest Door is closed and 4 to 5 VDC when the syringe nest door is open approximately $\frac{1}{4}$ "-3/8".
 - > If the digital voltmeter shows the Syringe Nest opening and closing, replace components in the following order (power down the Injector and the Remote Control before each replacement and retest the system after each replacement):
 - (1) Single Board Computer (see Section 5.4.3 – Replacing the Single Board Computer).
 - (2) Controller PCB (see Section 5.4.4 – Replacing the Controller PCB).
 - > If the digital voltmeter does not show the Syringe Nest Door opening and closing, proceed to the next step.
4. Disconnect the breakout box from the Injector Controller PCB and test the pin #1 path on the 24-pin connector as follows:
 - a. Remove the Injector Controller Cable Cover (see Section 5.4.1 – Replacing the Injector Controller Cable Cover) and disconnect the 24-pin connector from the back of the Controller PCB (see Figure 4-19b).
 - b. Remove the Injector Head Rear Enclosure (see Section 5.5.1 – Replacing the Injector Head's Rear Enclosure) and disconnect the 24-pin connector from J1 on the Interconnect PCB (see Figure 4-19c).

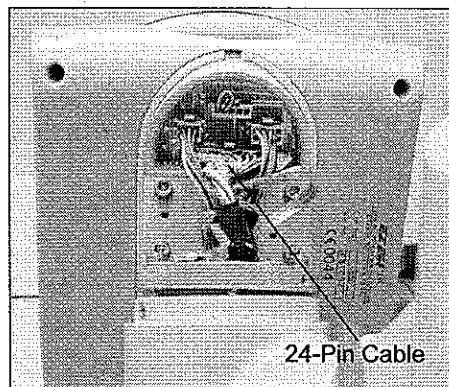


Figure 4-19b: Controller PCB

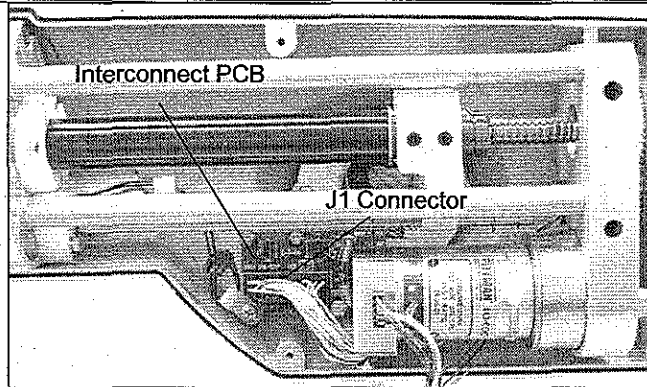


Figure 4-19c: Injector Head Front Enclosure

- c. Use the digital voltmeter to test the pin #1 path for open and for shorts with other pins.
- > If the pin #1 path has an open or is shorted to another pin, replace the 24-pin cable (see Section 5.3.3 – Replacing the 24-Pin Cable).
 - > If the pin #1 path is good, replace components in the following order (power down the Injector and the Remote Control before each replacement and retest the system after each replacement):
 - (1) Door Sensor (see Section 5.5.5 – Replacing the Door Sensor).
 - (2) Interconnect PCB (see Section 5.5.9 – Replacing the Interconnect PCB).
 - (3) Controller PCB (see Section 5.4.4 – Replacing the Controller PCB).

4.7.4 Syringe Warmer Does Not Warm

The Syringe Warmer activates after the system has been initialized and contrast has been loaded. To determine if the warmer is operational, hold it for several seconds. It will feel warmer than room temperature.

The Syringe Warmer will timeout after 60 minutes if the Injector Ram has not returned back to the Replace Syringe position and it will turn itself off.

If the Syringe Warmer fails to get warm, do the following:

Required Test Equipment: digital voltmeter

1. Set the Injector's power switch to the off position.
2. Disconnect the Syringe Warmer from the Injector Head. Use the digital voltmeter to make the following resistance measurements on the Syringe Warmer's connector:
 - a. The resistance across pin #3 and pin #4 should be between 9 to 12 kohms (thermistor).
 - b. The resistance across pin #1 and pin #2 should be between 120 to 160 ohms (heater).
 - > If either or both measurements fail, replace the Syringe Warmer (see Section 5.5.2 – Replacing the Syringe Warmer).
 - > If both measurements pass, proceed to the next step.

3. Reinstall the Syringe Warmer on the Injector Head. Use the digital voltmeter to make resistance measurements on the 24-pin cable as follows:

- a. Remove the Injector Controller Cable Cover (see Section 5.4.1 – Replacing the Injector Controller Cable Cover) and disconnect the 24-pin connector from the back of the Controller PCB (see Figure 4-20).

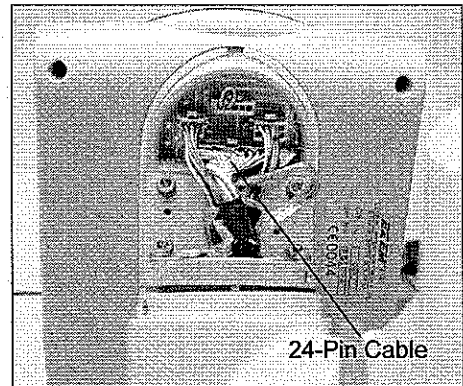


Figure 4-20: Controller PCB

- b. The resistance across pin #19 (gray on white) and pin #23 (orange on yellow) should be between 9 to 12 kohms (thermistor).
- c. The resistance across pin #1 (black) and pin #14 (orange on white) should be between 120 ohms to 160 ohms (heater).
 - > If either or both measurements fail, skip to Section 4.7.4.2 – 24-Pin Cable, Heater Harness, and Interconnect PCB Troubleshooting.
 - > If both measurements pass, go to Section 4.7.4.1 – Controller PCB and Single Board Computer Troubleshooting.

4.7.4.1 Controller PCB and Single Board Computer Troubleshooting

Perform this step only if both measurements in Step 3 (Section 4.7.4 – Syringe Warmer Doesn't Warm) passed.

*Required Test Equipment: digital voltmeter
breakout box*

1. Remove the Injector Controller's Front Enclosure (see Section 5.4.2 – Replacing the Injector Controller's Front Enclosure).

2. Test the system as follows:

- a. Connect the breakout box's ribbon cable to the Controller PCB (see Figure 4-21).

- b. Connect the digital voltmeter test leads to the breakout box (pin #6 = + VDC, pin #34 = Gnd).

- c. Power up the system and perform the load syringe, initialize, and fill with contrast procedures (loading actual contrast is not necessary). The Syringe Warmer should activate. It should measure between 2.0 to 3.0 VDC.

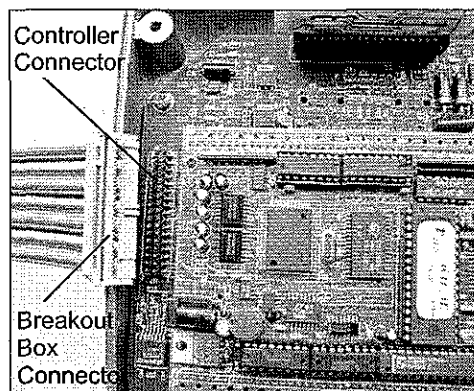


Figure 4-21: Connecting the Breakout Box

*Hint: To reactivate the warmer without emptying contrast that may be currently loaded: power down the Injector, then power it back up again and press the **MANUAL** membrane key on the Injector Controller.*

- > If the voltage is outside specification, replace the Controller PCB (see Section 5.4.4 – Replacing the Controller PCB).
 - > If the voltage is within specification, continue to Step 4d.
- d. Connect the digital voltmeter test leads to the breakout box (pin #1 = + VDC, pin #34 = Gnd). It should measure between 4 to 5 VDC.
 - > If the voltage is outside specification, replace the Single Board Computer (see Section 5.4.3 – Replacing the Single Board Computer).
 - > If the voltage is within specification, replace the Controller PCB (see Section 5.4.4 – Replacing the Controller PCB).

4.7.4.2 24-Pin Cable, Heater Harness, and Interconnect PCB Troubleshooting

Perform this step only if one or both measurements in Step 3 (Section 4.7.4 – Syringe Warmer Doesn't Warm) failed.

Required Test Equipment: digital voltmeter

1. Remove the Injector Controller Cable Cover (see Section 5.4.1 – Replacing the Injector Controller Cable Cover) and disconnect the 24-pin connector from the back of the Controller PCB (see Figure 4-22a).
2. Remove the Injector Head Rear Enclosure (see Section 5.5.1 – Replacing the Injector Head's Rear Enclosure) and disconnect the 24-pin connector from J1 on the Interconnect PCB (see Figure 4-22b).

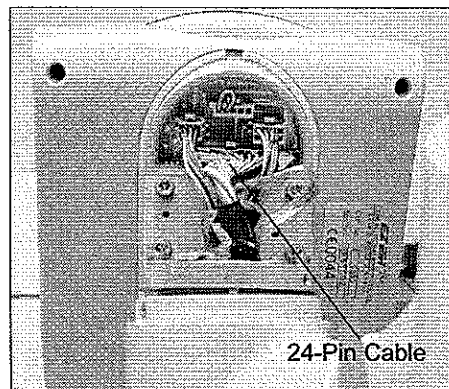


Figure 4-22a: Controller PCB

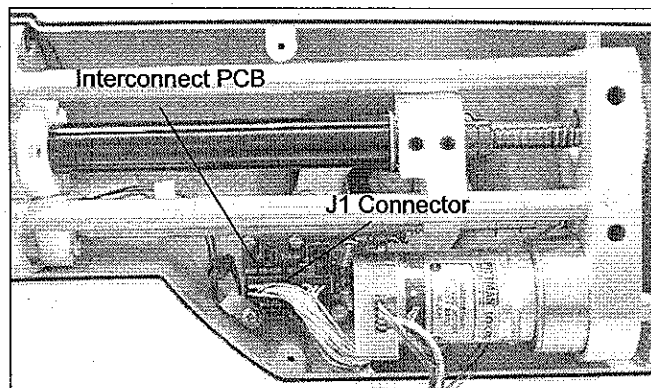


Figure 4-22b: Injector Head Front Enclosure

3. Use the digital voltmeter to test the paths for pin #1 (black), pin #14 (orange on white), pin #19 (gray on white), and pin #23 (orange on yellow) for opens and for shorts with other pins.
 - > If any path has an open or a short, replace the 24-pin cable (see Section 5.3.3 – Replacing the 24-Pin Cable).
 - > If all paths are good, replace components in the following order (power down the Injector and the Remote Control before each replacement and retest the system after each replacement):

- (a) Heater Harness (see Section 5.5.3 – Replacing the Heater Harness).
- (b) Interconnect PCB (see Section 5.5.9 – Replacing the Interconnect PCB).

4.7.5 Membrane Keys on Injector Controller Malfunction

Normally, a fault code is displayed if the system does not respond when a membrane key is pressed. Look up the fault code (see Section 4.6 – Fault Codes) for further instructions. Use the following procedure only when the system does not respond to a membrane key and does not display a fault code.

Required Test Equipment: digital voltmeter

1. Power down the Injector.
2. Remove the Injector Controller's Front Enclosure and disconnect both ribbon cables from the Controller PCB (see Section 5.4.2 – Replacing the Injector Controller's Front Enclosure). Place the Front Enclosure on a clean work area.
3. For each membrane key (see Figure 4-23) place the digital voltmeter test leads across the related pins (see Table 4-2) on the ribbon connector and measure the resistance. Observe the resistance while pressing and releasing the key several times. The digital voltmeter should show a closed circuit (approximately 0 ohms) while the key is depressed and an open circuit when the key is released.

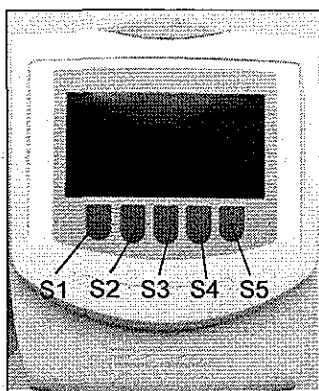


Figure 4-23: Membrane Keys

Key	Pins
S1	1 and 2
S2	1 and 3
S3	1 and 4
S4	1 and 5
S5	1 and 6

Table 4-2: Membrane Keys

- > If at least one measurement does not show a closed circuit, replace the Membrane Panel (see Section 5.4.7 – Replacing the Membrane Panel).
- > If all measurements show a closed circuit, replace components in the following order (power down the Injector and the Remote Control before each replacement and retest the system after each replacement):

responds when shorts or opens occur at either Pendant Switch or associated circuitry.

Problem	Injector Controller Displays	Remote Control Displays	Overall System Response
Short circuit detected at Injector Controller Pendant Switch at power up.	SYSTEM FAULT No. 244 INTERNAL FAULT RE-POWER INJECTOR OR CALL FOR SERVICE	SYSTEM FAULT No. 244 AN INJECTOR HARDWARE FAULT WAS DETECTED RE-POWER INJECTOR OR CALL FOR SERVICE	Injector Controller sounds a steady tone.
Short circuit detected at Remote Control Pendant Switch at power up.	No Display	Check or Release Pendant	System cannot be armed.
Short circuit detected at Injector Controller Pendant Switch after successful power up.	When attempting to Arm system, Injector Controller displays: Check or Release Pendant	No Display	System cannot be armed.
Short circuit detected at Remote Control Pendant Switch after successful power up.	No Display	When attempting to Arm system, Remote Control displays: Check or Release Pendant	System cannot be armed.
Open circuit at Pendant Switch	No Display	No Display	Injection procedure cannot be paused or re-started by pressing Pendant Switch.

Table 4-3: Pendant Switch Faults

4.7.8.1 Short Circuit at Pendant Switch

The system indicates that there is a short circuit at the Pendant Switch by displaying **SYSTEM FAULT No. 244** or **Check or Release Pendant** at the Injector Controller or Remote Control (see Table 4-3).

1. Power down the Injector and Remote Control, disconnect all Pendant Switches then power the Injector and Remote Control back up again.
 - > If the problem still exists, skip to Step 3.
 - > If the problem no longer exists and only one Pendant Switch was originally connected to the system, replace the Pendant Switch.
 - > If the problem no longer exists and two Pendant Switches were originally connected to the system, proceed to the next step.

2. Power down the Injector and Remote Control, reconnect one of the original Pendant Switches to the Injector Controller then power the Injector and Remote Control back up again.
 - > If the problem reoccurs, replace the connected Pendant Switch.
 - > If the problem does not reoccur, replace the remaining Pendant Switch.
3. Perform this step only if the problem remained after disconnecting all Pendant Switches in Step 1. Refer to Table 4-3 and determine if the problem is with the Injector Controller or the Remote Control.
 - > If the problem is with the Remote Control, replace components in the following order (power down the Injector and the Remote Control before each replacement and retest the system after each replacement):
 - (a) If field-servicing, replace the Remote Communication Box Assembly (see Section 5.7.2 – Replacing the Remote Communication Box Assembly). If factory-servicing, replace the Remote PCB Assembly (see Section 5.7.5 – Replacing the Remote PCB Assembly).
 - (b) Remote Control (see Section 5.9.7 – Replacing the Remote Control).
 - > If the problem is with the Injector Controller, proceed to the next step.

4. Perform this step only if the problem is with the Injector Controller. Do the following:
 - a. Power down the system and remove the Injector Controller's Front Enclosure and the Controller PCB (see Section 5.4.4 – Replacing the Controller PCB).
 - b. Disconnect the Pendant Port Cable Assembly from the back of the Controller PCB (see Figure 4-24).
 - c. Reinstall the Injector Controller PCB and the Injector Controller's Front Enclosure (see Section 5.4.4 – Replacing the Controller PCB).
 - d. Power up the Injector and observe if the problem still exists.
 - > If the problem no longer exists, replace the Pendant Port Cable Assembly (see Section 5.4.9 – Replacing the Injector's Pendant Port Cable Assembly).
 - > If the problem still exists, replace components in the following order (power down the Injector Controller before each replacement and retest the system after each replacement):
 - (a) Single Board Computer (see Section 5.4.3 – Replacing the Single Board Computer).
 - (b) Controller PCB (see Section 5.4.4 – Replacing the Controller PCB).

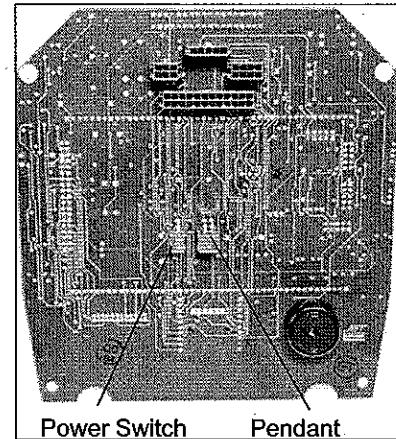


Figure 4-24: Controller PCB (Back)

4.7.8.2 Open Circuit at Pendant Switch

If an injection procedure fails to pause or restart when the Pendant Switch is pressed, an open circuit is suspect.

Required Tools: Phillips screwdriver
Flat-edge screwdriver

Required Test Equipment: digital voltmeter

1. If a Pendant Switch doesn't work at the Injector Controller, connect it at the Remote Control and retest. Similarly, if a Pendant Switch doesn't work at the Remote Control, connect it at the Injector Controller and retest.

- > If the Pendant Switch fails at the Injector Controller and at the Remote Control, replace the Pendant Switch. If the Pendant Switch fails only at the Injector Controller, proceed to Step 2.
 - > If the Pendant Switch fails only at the Remote Control, replace components in the following order (power down the Remote Control before each replacement and retest the system after each replacement):
 - (a) If field-servicing, replace the Remote Communication Box Assembly (see Section 5.7.2 – Replacing the Remote Communication Box Assembly). If factory-servicing, replace the Remote PCB Assembly (see Section 5.7.5 – Replacing the Remote PCB Assembly).
 - (b) Remote Control (see Section 5.9.7 – Replacing the Remote Control).
2. If the Pendant Switch fails only at the Injector Controller, do the following:
- a. Set the Injector's power switch to the off position.
 - b. Remove the Controller PCB (see Section 5.4.4 – Replacing the Controller PCB).
 - c. Using the digital voltmeter, test each path in the Pendant Port Cable Assembly for an open.
 - > If an open is detected in one or more paths, replace the Pendant Port Cable Assembly (see Section 5.4.9 – Replacing the Injector's Pendant Port Cable Assembly).
 - > If all paths are good, replace components in the following order (power down the Injector before each replacement and retest the system after each replacement):
 - (1) Single Board Computer (see Section 5.4.3 – Replacing the Single Board Computer).
 - (2) Controller PCB (see Section 5.4.4 – Replacing the Controller PCB).

4.7.9 Audible Tone Fails to Sound

An audible tone should sound when powering up the Injector and each time a membrane key on the Injector Controller is pressed. If no tone sounds and the system powers up correctly, replace the Controller PCB (see Section 5.4.4 – Replacing the Controller PCB).




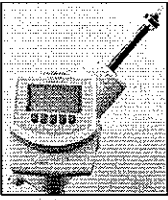
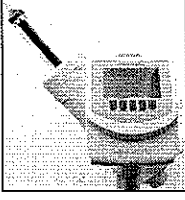
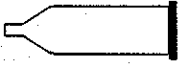
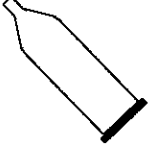

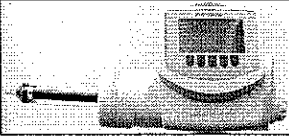
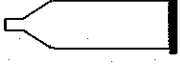
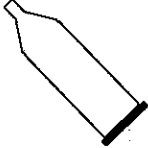
4.7.10 Remote Control Malfunction

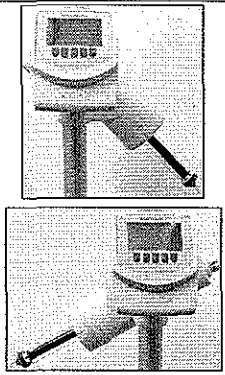


If none of the other troubleshooting procedures in this manual are applicable to the problem, replace the Remote Control (see Section 5.9.7 – Replacing the Remote Control).

4.7.11 Display Shows Wrong Injector Head Orientation

The Injector Controller and the Remote Control display a syringe graphic reflecting the current orientation of the Injector Head. The graphic rotates automatically as the operator manually rotates the Injector Head. Table 4-4 shows the orientation of the Injector and Remote graphics for the various Injector Head positions.

Table 4-4: Injector Head and Graphics Orientation

Injector Head	Injector Graphic	Remote Graphic
		
 		
 		

Injector Head	Injector Graphic	Remote Graphic
		

If the Injector graphic does not reflect the Injector Head orientation as shown in Table 4-4, do the following:

Required Test Equipment: digital voltmeter

1. Power down the Injector.
2. Remove the Injector Controller Cable Cover (see Section 5.4.1 – Replacing the Injector Controller Cable Cover) and disconnect the 24-pin connector from the back of the Controller PCB (see Figure 4-25a).
3. Remove the Injector Head's Rear Enclosure (see Section 5.5.1 – Replacing the Injector Head's Rear Enclosure) and disconnect the 24-pin connector from J1 on the Interconnect PCB (see Figure 4-25b).

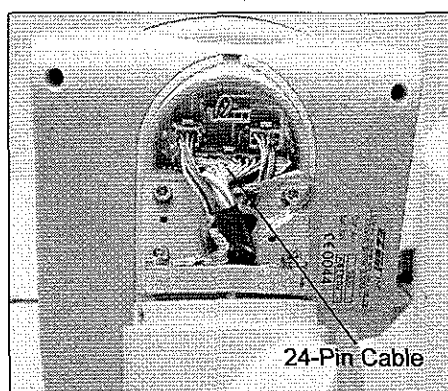


Figure 4-25a: Controller PCB

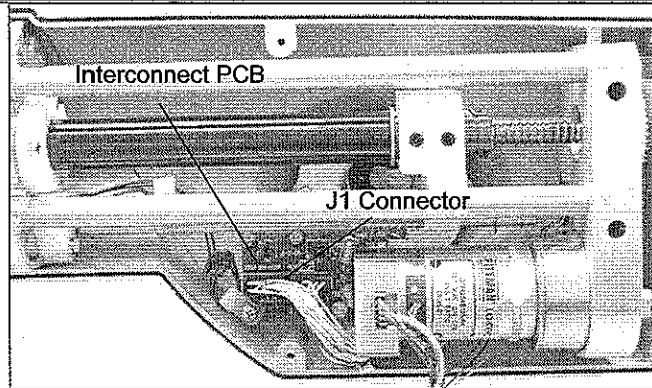


Figure 4-25b: Injector Head Front Enclosure

4. Use the digital voltmeter to test the paths for pin #15 (yellow on white), pin #16 (green on white), pin #17 (blue on white), and pin #18 (violet on white) for opens and for shorts with other pins.
 - > If any path has an open or a short, replace the 24-pin cable (see Section 5.3.3 – Replacing the 24-Pin Cable).
 - > If all paths are good, replace components in the following order (power down the Injector and the Remote Control before each replacement and retest the system after each replacement):
 - (a) Interconnect PCB (see Section 5.5.9 – Replacing the Interconnect PCB).
 - (b) Single Board Computer (see Section 5.4.3 – Replacing the Single Board Computer).
 - (c) Controller PCB (see Section 5.4.4 – Replacing the Controller PCB).

Section 5: Repairing and Replacing

5.1 ORGANIZATION

This section provides procedures for adjusting, removing, and replacing failed components that have been identified in Section 4 – Troubleshooting. It is divided into the following main parts:

- ◆ Injector Pivot JUNCTIONS
- ◆ Injector Controller
- ◆ Injector Head
- ◆ Power Supply
- ◆ Remote Control
- ◆ EDA

Each procedure is structured as follows:

- ◆ Title – identifies the component to be replaced.
- ◆ Required Tools – identifies the tools needed for the procedure.
- ◆ Removal Procedure – step-by-step instructions for removing the component.
- ◆ Replacement Procedure – step-by-step instructions for replacing the component and any test requirements.



- ◆ **Lethal voltages are present. Always power down the Injector and the Remote Control and unplug their AC power cords before beginning disassembly. Failure to comply may result in personal injury, death, or equipment damage.**
- ◆ **Always power down the Injector and Remote Control before connecting or disconnecting wires and cables.**
- ◆ **Electrostatic Sensitive Devices are present. Wear a wrist grounding strap and place components on an anti-static pad. Failure to comply may result in equipment damage due to electrostatic discharge.**
- ◆ All topics listed below are only **factory repairable**:
 - Controller PCB and SBC (must be changed as a set)
 - 24 Pin Interconnect Wire Harness
 - Power Supply